LOCAL STUDY OF ELECTRIC FIELD INDUCED PHASE TRANSITION ANTI-FERROELECTRIC-FERROELECTRIC IN LEAD-FREE BISMUTH FERRITE CERAMICS

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Bismuth ferrite doped by samarium ($Sm:BFO$) is one of the most perspective lead free piezoelectric. Sintering of $Sm:BFO$ ceramics with composition close to morphotropic phase boundary (MPB) significantly enhance piezoelectric coefficients and dielectric permittivity close to one obtained in lead zirconate titanate [1]. Recently we demonstrated that cycling of ceramics with MPB composition results in appearance of 'dual' strain mechanisms: ferroelectric/ferroelastic switching and a previously unreported electric field induced phase transition of an anti-polar intermediate phase. We showed that intermediate phases play an important role in the macroscopic strain response, and may have potential to enhance electromechanical properties at polar-to-non-polar MPBs [2].

Here we used scanning probe microscopy (SPM) in piezoresponse force microscopy (PFM) mode for the investigation of local phase transition from anti-polar to polar (R3c) phase. We demonstrated that application of electric field to SPM tip allows to induce phase transition locally under the tip. To exclude possible input of injected charges we used Kelvin probe microscopy. It was shown that injected charge has an exponential relaxation while R3C phase become stable ten of hours.

Dependences of the average radius of the formed R3c phase area on the amplitude and duration of voltage pulses was obtained. Dependences on voltage demonstrated linear behavior while dependence on duration was close to logarithmic. Characteristic parameters of phase transition were subsequently extracted. Peculiarities of the phase transition near the grain boundaries have been revealed.

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1. Aksel E., Jones L.J., Sensors. 10, 1935-1954 (2010).
2. Walker J., Simons H. et al., Sci. Rep. 6, 19630 (2016).
3. Walker J., Bryant P. et al., Acta mater. 83, 149-159 (2015).